Test Report issued under the responsibility of:

TÜVRheinland®

TEST REPORT
IEC 60825-1
Safety of laser products -
Part 1: Equipment classification and requirements

Report Number.....:	31782977.001
Date of issue.....:	9/13/2017
Total number of pages	17

Name of Testing Laboratory preparing the Report.....: TUV Rheinland of North America Inc.
1279, Quarry Ln., Ste A., Pleasanton, CA 94566

Applicant's name .....:	STMicroelectronics (Grenoble 2)
Address.....:	SAS 12, rue Jules HOROWITZ 38000 FRANCE

Test specification:

Standard.....:	IEC/EN 60825-1:2014 (Third Edition)
Test procedure .....:	CB
Non-standard test method .....:	N/A

Test Report Form No. .....:	IEC60825_1E
Test Report Form(s) Originator ....:	ÖVE
Master TRF.....:	Dated 2014-07

If this Test Report Form is used by non-IECEE members, the IECEE/IEC logo and the reference to the CB Scheme procedure shall be removed.

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

General disclaimer:

The test results presented in this report relate only to the object tested.
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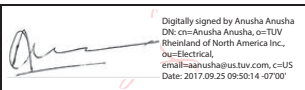
Test item description.....:	Ranging Sensor module
Trade Mark.....:	life.augmented

Manufacturer ..... :	Same as applicant
Model/Type reference ..... :	VL53L1, VL53L3
Ratings ..... :	Optional

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	**CB Testing Laboratory:**	TUV Rheinland of North America Inc.	
Testing location/ address.....:		1279, Quarry Ln., Ste A, Pleasanton, CA 94566	
☐	**Associated CB Testing Laboratory:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:		Anusha Anusha	
Approved by (name, function, signature)...:		Ernesto Fernandez	
☐	**Testing procedure: TMP/CTF Stage 1:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: WMT/CTF Stage 2:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Witnessed by (name, function, signature) .:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: SMT/CTF Stage 3 or 4:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Witnessed by (name, function, signature) .:			
Approved by (name, function, signature)...:			
Supervised by (name, function, signature) :			

List of Attachments (including a total number of pages in each attachment):

-Product Specifications (33 pages)

- Laser source specifications (8 pages)

Summary of testing:

All testing done under CB Report 095-72120194-000 and CB certificate DE 3-B0010

Tests performed (name of test and test clause):	**Testing location:**
Clause 5	TUV SUD America Inc. 10040 Mesa Rim Rd., San Diego, CA 92121, USA

Summary of compliance with National Differences:

List of countries addressed

N/A

☒ **The product fulfils the requirements of** IEC/EN 60825-1:2014, 3rd Ed.

Copy of marking plate

Device is a chip sensor module, too small to be marked. Following information placed on the packaging.

Test item particulars.....:	
Classification of installation and use.....:	Laser Class 1
Supply Connection.....:	SELV, provided by host equipment
.....:	
Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement.....:	P (Pass)
- test object does not meet the requirement.....:	F (Fail)
Testing.....:	
Date of receipt of test item .....:	1/31/2017 (TUV Sud CB Report # 095-72120194-000 and Cert# DE3-B0010)
Date (s) of performance of tests.....:	2/21/2017 – 2/22/2017 (TUV Sud CB Report # 095-72120194-000 and Cert# DE3-B0010)

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Manufacturer's Declaration per sub-clause 4.2.5 of IECEE 02:

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided ..... :	☐ **Yes** ☒ **Not applicable**

When differences exist; they shall be identified in the General product information section.

Name and address of factory (ies).....:	Shenzhen STS Microelectronics Co. Ltd. 16, Tao Hua Rd., Futian Free Trade Zone, 51048 Shenzhen, PRC

General product information:

The product covered by this report is a ranging laser diode component. It is not intended for the user to direct the laser beam into the eyes of any bystanders. The unit consists of a VCSEL laser diode, a band pass filter and a photodetector. It is intended for built in use. The products intended function is to emit pulsed laser radiation into free space. Access to radiation is possible during normal recommended operation and maintenance. Radiation is emitted only through the intended aperture located on the one side of the device. The product was determined to be a Class 1 laser product employing Class 1 laser radiation.

This report is based on TUV Sud CB report No 095-72120194-000 and CB certificate No. DE 3-B0010 for model VL53L1 .

Model VL53L3 is similar to VL53L1 except for the changes in the cap and substrate. All testing done of VL53L1 is representative of the other models.

Conditions of Acceptability and Laser Power Level Classification Considerations:

- The product is a component type device, it is tested with the manufacturer provided test board and software to generate the max. optical output power. Additional test shall be conducted at the end product if the operating conditions change

- Only hazards resulting from laser radiation have been addressed within this report.

IEC 60825-1			
Clause	Requirement + Test	Result - Remark	Verdict
4	**CLASSIFICATION PRINCIPLES**		
4.3	Classification rules		---
4.3 a	Radiation of a single wavelength	Single wavelength 930-950nm	P
4.3 b	Radiation of multiple wavelengths		N/A
	1) Laser product emits at two or more wavelengths shown as additive in Table 1		N/A
	2) Laser product emits at two or more wavelengths not shown as additive in Table 1		N/A
4.3 c	Radiation from extended sources (see 5.4.3)	Point source considered	N/A
4.3 d	Non-uniform, non-circular or multiple apparent source		N/A
4.3 e	Time bases		---
	1) 0,25 s		N/A
	2) 100 s	Considered	P
	3) 30000 s		N/A
4.3 f	Repetitively pulsed or modulated lasers	Considered, measured pulsed laser with approximately 37.5% duty cycle	P
	1) Any single pulse	Considered	P
	2) Average power for pulse trains	Measured average power: 0.208mW (@100mm) 0.420mW (@70mm)	P
	3) Pulse duration $t \leq T_i$ .....: Number of pulses N and C_5.....:	$T<T_i$ (4.8ns<5µs) N= 100s/ 5µs = 2 X 10^7 > 600 Then C_5 =5 $N^{-0.25}$ = 0.0747 <0.4 Take C_5 = 0.4 (also consider IEC 60825-1:2207 as below, N=100s/18µs = 5.56 X 10^6 C_5 = $N^{-0.25}$ = 0.02)	P
	3) Pulse duration $t > T_i$.....: Number of pulses N and C_5 .....:		N/A
4.4	Laser products designed to function as conventional lamps.	Not intended for use as a lamp	N/A
	α measured at 200 mm distance from closest point of human access (α > 5 mrad).		N/A
	Un-weighted radiance L measured at 200 mm distance (comparison with L_T = 1 $MWm^{-2}sr^{-1}/\alpha$) under reasonably foreseeable single fault conditions.		N/A

IEC 60825-1			
Clause	Requirement + Test	Result - Remark	Verdict
	Evaluation of emission according to IEC 62471 series (optional): Standard applied (IEC 62471 series)……,…..….: Risk Group……..….: Labelling…… ...: Classification of product based on accessible laser radiation (if no laser radiation accessible: Class 1).		N/A

5	**DETERMINATION OF THE ACCESSIBLE EMISSION LEVEL and PRODUCT CLASSIFICATION**		
5.1	Tests		---
	Compliance under reasonably foreseeable single fault conditions.	Considered	P
5.3	Determination of the class of the laser product ...: For Class 1C: vertical safety standard applied with requirements for Class 1C.	Class 1 product	---
5.4	Measurement geometry		---
5.4.1	General		---
5.4.2	Default (simplified) evaluation	Considered	P
	Conditions applied .....:	Conditions 1 and 3 (Condition 2 also considered to include IEC 60825-1:2007)	P
	Aperture diameter .....:	50mm, 7mm (7mm)	P
	Reference point :.....:	Laser diode	P
	Measurement distance .....: (for each condition)	2000mm, 100mm,(70mm)	P
5.4.3	Evaluation condition for extended sources		N/A
	Conditions applied .....:		N/A
	Most restrictive position .....: (distance from reference point)		N/A
	Angular subtense of the apparent source α and C_6: (for each condition)		N/A
5.4.3 a	Aperture diameters (for each condition). .....:		N/A
5.4.3 b	Angle of acceptance (for each condition)……...:		N/A

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Clause	Requirement + Test	Result - Remark	Verdict

6	**ENGINEERING SPECIFICATIONS**		**P**
6.2	Protective housing		---
6.2.1	General		---
	Protective housing prevents access to energy levels in excess of the AEL for Class 1.	Component type product, Class 1 radiation Protective housing to be evaluated at end product level	N/A
	Protective housing prevents access to energy levels equivalent to Class 4 and withstands exposures under reasonably foreseeable single fault conditions.	See above	N/A
	Maintenance of Class 1, 1C, 1M, 2, 2M, or 3R (access to emissions of Class 3B or 4 is prevented).		N/A
	Maintenance of Class 3B product (access to emission of Class 4 is prevented).		N/A
6.2.2	Service	Not serviceable	N/A
6.2.3	Removable laser system (laser system complies with requirements of Clauses 6 and 7).	Embedded laser diode not removable	N/A
6.3	Access panels and safety interlocks		---
6.3.1	Panel is intended to be removed during operation (or maintenance) and would give access to higher energy levels (see Table 13).	No access panels	N/A
	Accessible emission (after removal of the panel) corresponds to product Class (designated by “X” in Table 13)		N/A
	Emission through the opening if interlocked panel of Class 1, 1C, 1M, 2, or 2M is removed (Emission < AEL of Class 1M or 2M).		N/A
	Emission through the opening if interlocked panel of Class 3R, 3B, or 4 is removed (Emission < AEL of Class 3R).		N/A
	Requirements regarding reasonably foreseeable single fault condition.		N/A
6.3.2	Override mechanism	No override mechanism	N/A
	Behaviour of override in operation when the panel is replaced.		N/A
	Visible or audible warning for override mode.		N/A
6.4	Remote interlock connector	Laser Class 1	N/A
6.5	Manual reset	Laser Class 1	N/A
6.6	Key control	Laser Class 1	N/A

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Clause	Requirement + Test	Result - Remark	Verdict
6.7	Laser radiation emission warning		---
6.7.1	Laser product is a 3R (λ<400 nm; λ>700 nm), 1C, 3B or 4 laser systems.	Laser Class 1	N/A
6.7.2	Audible or visible warning.	Laser Class 1	N/A
	Warning is failsafe or redundant.		N/A
	Viewing of the visible warning does not require exposure to emissions > AEL for Class 1M and 2M.		N/A
6.7.3	Operational control and laser aperture are provided with a warning device when they are separated more than 2 m from warning device.	Laser Class 1	N/A
6.7.4	Visible indication of output aperture if laser emission may be distributed through more than one output.	Single output	N/A
6.7.5	Switch for handheld Class 3R device must be depressed for emission (in lieu of emission indicator).	Not such a device	N/A
6.8	Beam stop or attenuator	Laser Class 1	N/A
6.9	Controls	Laser Class 1	N/A
6.10	Viewing optics	No viewing optics	N/A
	a) Human access to laser radiation in excess of Class 1M prevented when the shutter is opened or attenuation varied.		N/A
	b) Opening of the shutter or variation of the attenuation prevented when exposure to laser radiation in excess of Class 1M is possible.		N/A
6.11	Scanning safeguard	No scanned radiation	N/A
6.12	Safeguard for Class 1C products	Laser Class 1	N/A
	a) Human access to laser radiation in excess of AEL for Class 1 measured under Condition 3 is prevented.		N/A
	b) Human access to laser radiation in excess of AEL for Class 3B measured through 3,5 mm aperture at 5 mm distance from applicator is prevented.		N/A
6.13	Walk-in access		N/A
	a) Means provided so that any person inside the housing can prevent activation of Class 3B or 4 laser hazards.	No walk-in access	N/A
	b) A warning device provides adequate warning of emission to any person within the housing.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	c) Where “walk-in” access during operation is intended or reasonably foreseeable, emission of laser radiation that is equivalent to Class 3B or 4 while someone is present inside the enclosure of Class 1, Class 2 or Class 3R product is prevented by engineering means.		N/A
6.14	Environmental conditions		---
	- climatic conditions	20-30°C ambient is considered, Pollution Degree 2	P
	- vibration and shock	End product evaluation. This report covers laser radiation hazards only	N/A
6.15	Protection against other hazards		---
6.15.1	Non-optical hazards (product safety standard)	Only hazards resulting from laser radiation have been addressed	N/A
	- electrical hazards;		N/A
	- excessive temperature;		N/A
	- spread of fire from the equipment;		N/A
	- sound and ultrasonics;		N/A
	- harmful substances;		N/A
	- explosion;	No explosive material	N/A
6.15.2	Collateral radiation	No collateral radiation	N/A
6.16	Power limiting circuit	No power limiting circuit is evaluated in this report. The worst case scenario drive current considered	N/A

7	**LABELLING**		
7.1	General		---
	Labels durable, permanently affixed	Product is Laser class 1. Labelling optional.	N/A
	Labels clearly visible		N/A
	Reading of labels is possible without exposure to laser radiation in excess of AEL for Class 1.		N/A
	Colour combination		N/A
	Labelling impractical due to the size or design of the product.		N/A
	Warning label – Hazard symbol (Figure 3)		N/A
7.2 - 7.7	Text on explanatory label or pictogram (laser class, warning text)	Laser Class 1, optional	N/A

IEC 60825-1			
Clause	Requirement + Test	Result - Remark	Verdict
7.8	Aperture label	Laser Class 1, optional	N/A
7.9	Radiation output and standards information		---
	Max output of laser radiation .....:	Laser Class 1, optional	N/A
	Pulse duration .....:	Laser Class 1, optional	N/A
	Emitted wavelength(s) .....:	Laser Class 1, optional	P
	Name and publication date of the standard .....:	Laser Class 1, optional	P
7.10	Labels for access panels		---
7.10.1 a) – f)	Labels for panels - warning wording used .....:	No access panels	N/A
7.10.2	Labels for safety interlocked panels - Warning wording used .....:		N/A
7.11	Warning for invisible laser radiation .....:	Laser Class 1, optional	N/A
7.12	Warning for visible laser radiation .....:	Invisible radiation only	N/A
7.13	Warning for potential hazard to the skin or anterior parts of the eye - warning wording used .....:		N/A

8	**OTHER INFORMATIONAL REQUIREMENTS**		
8.1	Information for the user		---
	a) adequate instructions for assembly, maintenance and safe use and description of the classification limitations, if appropriate.	Provided in the manual	P
	b) additional warning for Class 1M and 2M	Laser Class 1	N/A
	c) laser beam parameters for radiation above the AEL of Class 1	Laser Class 1	---
	• Wavelength .....:		N/A
	• Beam divergence .....:		N/A
	• Pulse pattern .....: (pulse duration, repetition rate, …)		N/A
	• Maximum power or energy output .....:		N/A
	d) safety instruction for embedded laser products and other incorporated laser products.	No embedded laser product	N/A
	e) MPE and NOHD for Class 3B and 4 laser products; For collimated beam Class 1M and 2M lasers the extended NOHD (ENOHD).	Laser Class 1	N/A
	f) information for the selection of eye protection.	Laser Class 1	N/A
	g) reproduction of all required labels and warnings.	Provided	P
	h) location of laser apertures	Emitted from module	P

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Clause	Requirement + Test	Result - Remark	Verdict
	i) list of controls, adjustments of procedures for operation and maintenance - and warning statement.	Provided in the manual	P
	j) information (compatibility requirements) about laser energy source if not incorporated.	End product evaluation	N/A
	k) additional warning for Class 1, 1M, 2, 2M, and 3R regarding skin or corneal burns.	Laser Class 1	N/A
	l) Information for Class 1C products (e.g. warning that repeated application may pose a risk).	Laser Class 1	N/A
8.2	Purchasing and service information		P
	a) safety classification of each laser product stated in all descriptive material (e.g. brochures).	Provided in the manual	P
	b) adequate instructions for servicing available: • warnings and precautions regarding exposure of laser emission above Class 1 • maintenance schedule • list of controls and procedures that could increase accessible emissions • description of displaceable parts • protective procedures for service personnel • reproduction of labels and hazard warnings	Provided in the manual	P
9	**ADDITIONAL REQUIREMENTS FOR SPECIFIC LASER PRODUCTS**		
9.1	Applicable other parts of the standard series IEC 60825		---
	IEC 60825-2 (Safety of optical communication systems)	Component for built in use. To be evaluated in system configuration	N/A
	IEC 60825-4 (Laser guards)		N/A
	IEC 60825-12 (Safety of free space optical communication systems used for transmission of information)		N/A
9.2	Medical laser products: Class 3B and Class 4 medical laser products comply with IEC 60601-2-22		N/A
9.3	Laser processing machines: Comply with IEC/ISO 11553 series.		N/A
9.4	Electric toys: Comply with IEC 62115		N/A
9.5	Consumer electronic products: Comply with IEC 60950 (IT-equipment) or IEC 60065 (AV equipment)		N/A

	TABLE: Critical components information				P
Object / part No.	**Manufacturer/ trademark**	**Type / model**	**Technical data**	**Standard**	**Mark(s) of conformity[1)]**
Laser diode	Philips	ULM940-01-TN-H0101L	930-950nm, 3.5mA, 2.3Vdc	IEC 60825-1	Tested in application
- Description:					
Supplementary information: [1)] Provided evidence ensures the agreed level of compliance. See OD-CB2039.					

List of test equipment used:

Clause	Measurement / testing	Testing / measuring equipment / material used, (Equipment ID)	Range used	Last Calibration date	Calibration due date
All testing conducted under TUV Sud CB report No. 095-72120194-000 and CB certificate No. DE 3 –B0010					

Further remarks:

ANNEX A:

ANNEX B: